

THE NEW GUINEA GENUS *COPIULA* MÉHELY¹ (ANURA: MICROHYLIDAE): A NEW DIAGNOSTIC CHARACTER AND A NEW SPECIES

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Summary

BURTON, T. C. (1990) The New Guinea genus *Copiula* Méhely (Anura: Microhylidae): a new diagnostic character and a new species. *Trans. R. Soc. S. Aust.* 114(2), 87-93, 31 May, 1990.

Copiula Méhely possesses a unique condition of the deltoid musculature. The nature of the throat musculature of *Copiula* suggests a phylogenetic affinity to *Sphenophryne*. *Copiula tyleri* sp. nov. a widespread species, occurring in the north of the New Guinea mainland, is characterized by an unpigmented tympanum, strong contrast between the mid-dorsal and latero-dorsal ground colour, a broad, short truncate snout, and nostrils that open laterally rather than anterolaterally. There remains a number of specimens of *Copiula* that cannot be associated confidently with any of the named species.

KEY WORDS: frog, microhylid, *Copiula*, pectoral muscles, deltoid, new species, morphology.

Introduction

Copiula Méhely (1901) was erected to accommodate *Phrynoxalus oxyrhinus* Boulenger (1898). Parker (1934) referred *Copiula* to the synonymy of *Cophixalus*, where it remained until Menzies & Tyler (1977), with access to newly available specimens, resurrected it for *C. oxyrhina* and two new species, *C. fistulans* and *C. minor*. Burton & Stocks (1986) described a fourth species (*C. pipiens*) from specimens collected in 1983. In their account of the systematics of *Copiula*, Menzies & Tyler (1977) emphasized three features that distinguish it from *Cophixalus* Boettger, the other genyophrynine genus then consisting of frogs lacking clavicles and procoracoids: (a) rostral glands and an associated translucent white tip to the snout; (b) premaxillae with broad-based alary processes; and (c) finger discs less expanded than toe discs.

There are problems with the above diagnosis. R. G. Zweifel (*in litt.*) points out that *Cophixalus paucus* and *C. sphagnteola* lack expanded finger discs so that the toe discs are broader at their tips than the fingers (Zweifel & Allison 1982). Moreover, Zweifel points out that some species of *Sphenophryne* (among them *S. schlaginhaufeni* (pers. obs.)) possess translucent, glandular tips to their snouts. Finally, I have been unable to confirm the difference in the morphology of the premaxillae: the alary processes of specimens of *Cophixalus riparius* and *C. ornatus* examined in this study are broad-based and appear similar in structure to those of *Copiula fistulans*. Paradoxically, species of *Copiula* are probably easier to assign to genus than any other genyophrynine species, but neither external morphology nor skeletal structures yield unequivocal characters to support the genus.

It is clear, however, that characters of the musculature are useful at all levels, including generic, in the systematics of microhylid frogs. Burton (1986) based much of his revision of the Asterophryinae on characters of the musculature. In the present study, muscles of the throat, pectoral girdle and foot provide useful information and are introduced here.

Frogs possess three transversely directed muscles between the mandibles: the *M. submentalis* (the most anterior), the *M. intermandibularis* and the *M. interhyoideus*. In addition, the microhylids possess one or more supplementary slips to the *M. intermandibularis* (Tyler, 1974¹; Emerson 1976). All of the genyophrynines possess one supplementary slip (Burton 1986), but exhibit diversity in its origin and orientation. This diversity has proven taxonomically useful at various levels (Tyler 1974¹; Burton 1984, 1986).

Burton (1983a²) showed that the condition shared by some members of all of the microhylid subfamilies that he examined was a single narrow supplementary slip arising via a tendon from posteriorly on the mandible and passing anteromedially, parallel with the mandible, to insert on a median tendinous mass underlying the junction of the mentomeckelians. This condition is figured for *Cophixalus ornatus* by Burton (1984) and *C. kainiensis* (Burton 1986). Its distribution through several subfamilies (Asterophryinae, Brevicipitinae, Dyscophinae, Genyophryinae and Microhylinae) suggests that it is the primitive condition, using the criterion of Kluge (1976) that a character state widespread among taxa related at

¹ Tyler, M. J. (1974) Superficial mandibular musculature and vocal sac structure of the Anura. M.Sc. thesis, University of Adelaide. Unpubl.

² Burton, T. C. (1983a) The phylogeny of the Papuan subfamily Asterophryinae (Anura: Microhylidae). Ph.D. thesis, University of Adelaide. Unpubl.

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the next higher taxonomic level that otherwise have little in common is plesiomorphic.

The deltoid muscle of frogs usually consists of two or three slips inserting on the humerus, the number of slips depending in part on the completeness of the pectoral girdle (Jones 1933). The *M. episternohumeralis*, arising from medially on the ventral surface of the sternum and/or episternum (depending on the presence of an episternum), and the *M. acromiohumeralis*, arising from the scapula, are apparently always present, however much the pectoral girdle may be reduced (Jones 1933; Burton 1983a²). Frogs with a "complete" pectoral girdle, i.e., including a fully developed clavicle, usually possess a small slip, the *M. cleidohumeralis*, arising from the ventral surface of the clavicle. No genyophryine, even if it possesses a clavicle, possesses this slip (Burton 1983a²).

The *M. acromiohumeralis* is generally (e.g., *Rana temporaria*, Ecker 1889; personal observations) a broad muscle consisting of (a) short fibres from the anterior margin of the scapula which insert along the ventral surface of the humerus, and (b) a long superficial strap-like portion which consists of parallel sets of fibres arising from two origins. The more medial fibres arise from laterally on the anterior margin of the acromion; the more lateral fibres arise from the medial surface of the scapula, pass laterally, curving around the dorsal surface of the acromion, and run alongside the more lateral fibres from the anterior margin of the acromion. This strap-like component of the deltoid musculature runs the length of the humerus, and inserts on the ulnar epicondyle of the humerus. In genyophryines of the genera *Cophixalus* and *Sphenophryne* examined in this study, these fibres arise distally on the posterior surface of the coracoid instead of the medial margin of the scapula.

Burton (1983a²) demonstrated that the foot and hand musculature of the New Guinea microhylids is very conservative and, therefore, useful taxonomically. In genyophryines a foot muscle, the *M. flexor ossis digiti IV*, typically arises from the fibulare and inserts along the whole length of the lateroplantar surface of metatarsus IV.

When Menzies & Tyler (1977) resurrected *Copiula* they dealt only with species from eastern New Guinea, while acknowledging the existence of specimens from the Cyclops Range in Irian Jaya, 800 km west of their most westerly site for *C. fistulans*. *Copiula pipiens* was subsequently described from Wewak, 500 km north-west of the species discussed by Menzies & Tyler (Burton & Stocks 1986). In the course of a broader study of *Copiula*, a series of morphologically distinctive

frogs was found to have been collected from a number of sites ranging from the Cyclops Range eastwards to within about 200 km north-west of the known range of *C. fistulans*.

Materials and Methods

The following specimens were examined for comparison with the new species, and are lodged in collections abbreviated as follows: AMNH - American Museum of Natural History, New York; AUZ - Department of Zoology, University of Adelaide (unregistered); BMNH - British Museum (Natural History, London); RMNH - Rijksmuseum van Natuurlijke Historie, Leiden; SAM - South Australian Museum, Adelaide; UPNG - Department of Biology, University of Papua New Guinea, Port Moresby.

Copiula fistulans Menzies & Tyler AMNH 59894-6, 81128-31, 82951-2; AUZ A723, D742; SAM R5852, R5879, R6282-3, R9443-8, R14239-50, R14497 (holotype), R18081, R23836-7; *C. minor* Menzies & Tyler AMNH 56908, 56939-40, 56958, 56960, 56971-2, 56986, 56997-8, 57046-7, 57050-4; SAM R15245 (paratype); *C. oxyrhina* (Boulenger) AMNH 59894-8, 59957-60, 59992-60000, 60013, 60018-9, 60036-46; BMNH 1947.2.11.99, 1947.2.12.4 (syntypes); SAM R 10647, R 14237-8, R18080; UPNG 1371, 2612, 4311, 5204-5; *C. pipiens* Burton & Stocks type series AMNH 123698; SAM R 29779 (holotype)-82; UPNG 7025-8 (incorrectly cited by Burton & Stocks (1986) as 7205-8); unidentified *Copiula*: AMNH 49536, 49554, 79961; BMNH 1938.6.6.2.3; RMNH 5256, 5269.

Other Genyophryinae: *Cophixalus ornatus* SAM R12321; *C. parkeri* SAM R5578A, R5818A, R5823A; *C. riparius* SAM R6145, R9125A; *Sphenophryne macrorhyncha* SAM R6395; *S. palmipes* SAM R1157.

Other Microhylidae: *Hylophorbus rufescens* SAM R6285B; *Kaloula picta* SAM R13603B; *Mantophryne lateralis* SAM R5881A, R9434A; *Phrynomantis hemicola compta* SAM R5825A; *P. strictogaster* SAM R5202.

Other families: Hylidae: *Litoria caerulea* SAM R23974; Leptodactylidae: *Limnodynastes peroni* SAM R24273; *L. dumerili* SAM R19100; Ranidae: *Rana grisea* SAM R8294B; *R. papua* SAM R7695.

Specimens were preserved in 65% or 70% ethanol. The following measurements were taken: Snout-vent length (S-V), head width (HW), head length (HL), tibial length (TL), Eye diameter (E), Eye-naris distance (E-N), internarial distance (IN), diameter of tympanum (T), and snout length (SN). Measurements were carried out using Mitutoyo dial calipers, and follow the methods of Burton & Stocks (1986). Myological dissections were facili-

tated by use of the iodine-potassium iodide solution of Bock & Shear (1972).

Specimens were, or had been, cleared and double-stained for skeletal examination according to the method of Dingerkus & Uhler (1977). Some specimens were flensed and cleared of soft tissue by application of sodium hypochlorite solution and allowed to dry slowly. Nomenclature of muscles and skeletal structures follows Burton (1986).

Myological Characters of *Copidula*

The superficial throat musculature of *Copidula* includes a single supplementary slip of the *M. intermandibularis*; a broad sheet arising from the anterior part of the ventral margin of the angulosplenic, and passing medially and only slightly anteriorly to insert on the ventral epimysium of the *M. submentalis* and the adjacent median aponeurosis of the anterior portion of the *M. intermandibularis*. This slip was illustrated by Burton (1986), and resembles closely that of *Sphenophryne* described and figured by Burton (1984).

The lack of clavicles and procoracoids led Parker (1934) to associate *Copidula* with *Cophixalus* but the nature of the throat musculature is stronger evidence of the phylogenetic relationships of *Copidula* with *Sphenophryne*, as it is clearly a synapomorphy (Burton 1986). It is likely that clavicles and procoracoids have been lost several times in the evolution of the New Guinea microhylids (Burton 1986) and that reduction of the pectoral girdle, therefore, is not a reliable phylogenetic character.

The deltoid musculature of *Copidula* (Fig. 1) resembles that of other genyophryines, except that the portion of the *M. acromiohumeralis* which arises from the coracoid of *Copidula* differs from that of other genyophryines in origin, course and insertion. In *Copidula* this portion has a broad origin occupying the middle one-half approximately of the anterior margin of the coracoid. The fibres of this portion converge as they pass anterolaterally across the anterior margin of the acromion (dorsal to the lateral surface of the humerus. Instead of merging with the strap-like portion from the acromion, as in other frogs, it passes medially, deep to the strap-like portion, and inserts on the crista ventralis and the adjacent lateroventral surface of the humerus. This condition is not found in other New Guinea microhylid genera, or in the other 22 microhylid genera examined by Burton (1986), and has not been reported for any other genus.

This unique muscle slip is found easily in dissection of the pectoral girdle, and in some spirit

specimens with translucent ventral skin (it can be seen clearly through a dissecting microscope sometimes without making an incision). In that the condition described here is found in all frogs referred to *Copidula* by the combination of characters presented by Menzies & Tyler (1977), and in that this slip is unique to *Copidula* and is relatively easy to find, possession of this condition of the deltoid musculature is diagnostic for *Copidula* and taxonomically useful.

The *M. flexor ossi digiti IV* of *Copidula* inserts only on the proximal one-half of the lateroplantar surface of metatarsus IV. This is the condition shared by most of the asterophryine genera but no other genyophryine, and is described and figured by Burton (1983 b). As it is a difficult muscle to

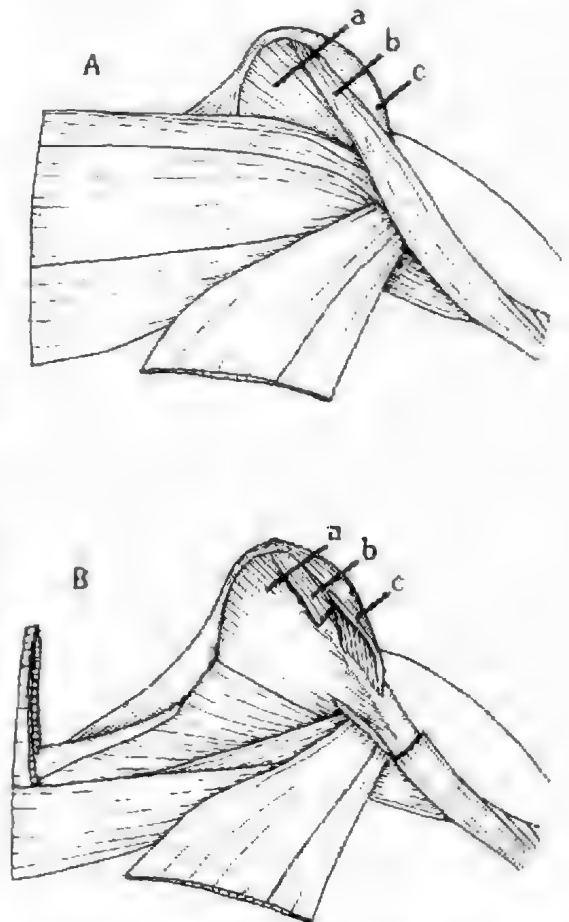


Fig. 1. Ventral views of the pectoral musculature of the left side of *Copidula tyleri*, sp. nov., showing the components of the *M. acromiohumeralis* A, with all muscles intact, and B, after removal of superficial muscles and severing of strap-like portion. a, short fibres from acromion; b, strap-like portion; c, portion originating from coracoid.

dissect, it is of use in phylogenetic studies rather than of taxonomic value.

Copiula tyleri sp. nov.
FIGS 2-5

Holotype: AMNH 77542, an adult male collected at Mt Hunstein, 1220 m, 142°39' E, 4°31' S, East Sepik Province, Papua New Guinea on 15.viii.1966 by R. Hoogland.

Definition: A small species with a conspicuously unpigmented tympanum; dorsum distinctly more heavily pigmented medially than laterally; snout relatively short ($SN/E < 1.40$) and broad; the nostrils opening laterally.

Description of holotype: Head roughly triangular, longer than broad (HL/HW 1.06) (Fig. 2). Head width more than $\frac{1}{2}$ snout to vent length (HW/S-V 0.36). Snout relatively short (SN/E 1.31), with rounded, translucent white tip projecting well beyond maxillae. Nostrils lateral; internarial distance much greater than eye to naris distance (E-N/IN 0.61). Canthus rostralis well defined and curved when seen from above; loreal region almost vertical. Eye small (E/S-V 0.106), but larger than eye-to-naris distance. Tympanum small (1.6 mm) and conspicuously unpigmented in contrast to dark pigment of side of head and scapula area; no supratympanic fold.

Tongue more than half free posteriorly. Single transverse prepharyngeal ridge present, denticulate.

Fingers and toes unwebbed (Fig. 3); terminal discs with marginal grooves; discs of toes broader than discs of fingers; order of lengths of fingers $3 > 4 > 2 > 1$; order of lengths of toes $4 > 3 > 5 > 2 > 1$; inner metatarsal tubercle small and oval; outer metatarsal tubercle absent.

Skin of dorsal and ventral surfaces smooth. Colour in preservative: dorsum mid purplish-brown medially, with indistinct dark brown to black blotches, grading laterally to a pale grey contrasting strongly with dark postorbital strips. Tip of snout unpigmented. Postorbital stripe broad and irregular, extending beyond arm. Flanks dark brown blotched pale grey. Tympanum golden-brown contrasting with dark postorbital stripe. Ventral surfaces pale.

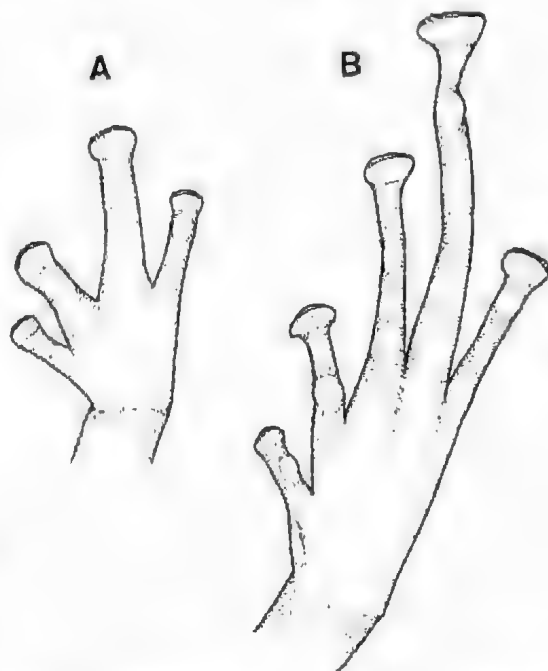


Fig 3. A, palmar surface on the left hand and B, plantar surface of the left foot of the holotype of *Copiula tyleri* sp. nov.

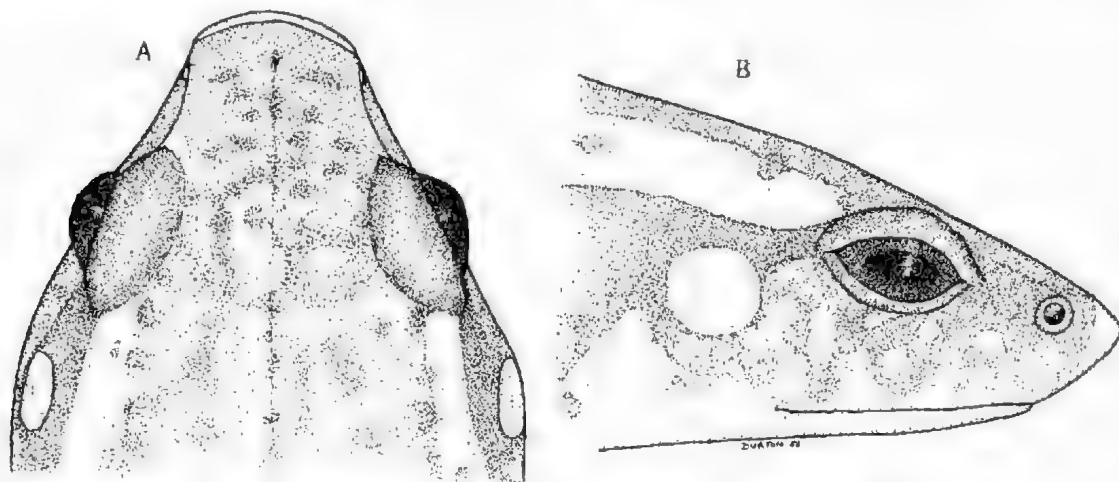


Fig. 2. A, dorsal and B, lateral views of the head of the holotype of *Copiula tyleri* sp. nov.

NEW *COPILA* SPECIES

cream-grey, suffused with brown in submandibular region and on undersurface of tibia and foot. Iliosacral articulation direct and ligamentous.

There is no information on the call of this species.

Dimensions of holotype: S-V 24.5 mm; HW 8.7 mm; HL 9.2 mm; TL 12.1 mm; E 2.6 mm; E-N 1.7 mm; IN 2.8 mm; T 1.6 mm; SN 3.4 mm.

Etymology: The species is named in honour of Michael J. Tyler, whose contribution to the taxonomy of Australian and New Guinean frogs is immense, who, with Menzies, resurrected *Copila*, and to whom the author is deeply indebted personally and professionally. It is evidence of the perversity of nature that the legs of *Copila tyleri* are as moderate in length as Tyler's aren't.

Variation

There are 13 paratypes: AMNH 78113 (gravid ♀), Mt Nebo, 700-1550 m, 20 km NE of Lumi, 142°2'E, 3°25'S, West Sepik Province, J. Diamond 14.vii.1966; AMNH 78114 (gravid ♀), Mt Menawa, Bewani Mtns, 15 km NE of Uta, 141°33'E, 3°22'S West Sepik Province, J. Diamond 2-8.viii.1966; AMNH 77543 (gravid ♀) collected with the holotype; AMNH 82949 (adult ♂), Wanuma, 145°20'E, 4°50'S, 670 m Adelbert Mtns, Madang Province, R. G. Zweifel 3.viii.1969; BMNH 1938.6.5.93-96,98 (adult ♂♂), 1938.6.5.97, 99 (immature ♀♀), Cyclops Range, 910-1220 m, Irian Jaya ca 140°40'E, 2°30'S, E. Cheesman; SAM R33774 (adult ♂) collected with the holotype. More precise data of sites and dates of capture are unavailable for the Cyclops Range specimens.

The adult males measure 19.6-24.5 S-V, and the females 24.2-25.5 mm S-V. The diameter of the largest unpigmented mature ovum observed is 2.9 mm. Hind limbs are moderately long (TL/S-V 0.45-0.49). HL/HW varies widely (0.93-1.13). SN/E is very low (1.20-1.31). E-N/IN varies between 0.60-0.79.

Coloration in preservative varies. In general specimens from the Cyclops Range are browner, sometimes honey-coloured, whereas specimens from elsewhere are grey-purple. Whether this reflects different length of preservation (the Cyclops Range specimens were collected approximately 30 years before the others), or the preservative practices adopted by collectors or museums, or any real difference is unclear. The postorbital stripe varies in breadth and extent, but it is broad and extends beyond the arm in all specimens.

Ventral colour ranges from pale mauve through pale cream, and in some specimens the ventral colour of the thigh is pale orange. Density of the mottling of the submandibular region varies from slight peppering to heavy mottling.

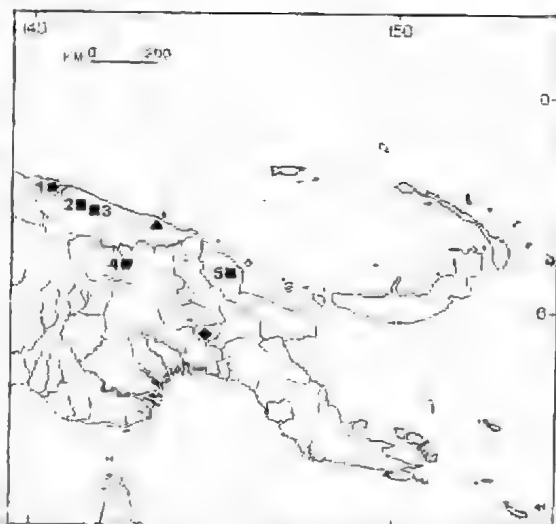


Fig. 4. Distribution of *Copila tyleri* sp. nov. in Eastern New Guinea, *C. pipiens* and an unidentified *Copila*. *C. tyleri*: squares, 1, Cyclops Ra; 2, Mt Bewani; 3, Mt Nebo; 4, Mt Hunstein; 5, Wanuma. *C. pipiens*: triangle Wewak district. Unidentified *Copila*: diamond Solibabeda.

Habitat and Distribution

In his field notes on AMNH 82949, R. G. Zweifel states, "I found this one hiding beneath a broad leaf on the forest floor in the daytime. When uncovered, it tried to hide in a hole in the ground". The Cyclops Range specimens were collected from "dense forest".

Information regarding the altitudes of collecting sites is sketchy, but the minimum range of altitudes is 670 m (Wanuma) to 1220 m (Mt Hunstein and Cyclops Ra). Collecting sites are marked on Fig. 4. All sites are to the north of the central highlands.

Colour in Life

R. G. Zweifel has supplied field notes of one of the paratypes (AMNH 82949): "Mid-dorsal area from snout to cloaca moderately dark brown edged laterally with lighter, more golden brown. There is a dark lateral band from the snout to mid-flank that is much darker brown than the middle of the back. A light yellow line separates this dark brown from the lighter brown of the snout along the canthus rostralis, and this line continues up over the edge of the eyelid. The upper surfaces of the limbs are much the same colour as the middle of the back but have a few lighter and darker speckles on them. The under surfaces are grayish white with a faint yellowish tinge in the groin and in the axillary regions. There is a general grey mottling on the chin which is much weaker on the chest and entirely absent on the lower abdomen. Similar mottling

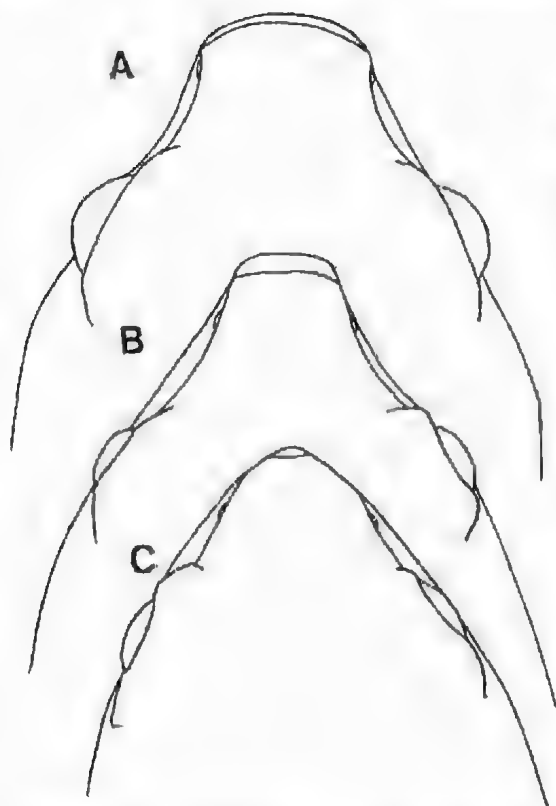


Fig. 5. Outlines of dorsal views of heads of A, *Copiula tyleri* sp. nov.; B, *C. pipiens* Burton & Stocks; C, *C. minor* Menzies & Tyler.

reappears on the under surfaces of the hind limbs. The iris is dark brown, almost black, with tiny golden flecks. The horizontal pupil is conspicuously margined with a reddish gold line".

Comparison with other species

Copiula tyleri sp. nov. is a small species (maximum size of adult males 24.5 mm, females 25.5 mm S-V), distinct on this account from *C. fistulans* adult males (25.1-29.2 mm, females 29.4-33.5 S-V). Unlike the other small species (*C. minor*, *C. oxyrhina*, *C. pipiens*) there is strong contrast between the dark mid-dorsum and paler lateral dorsum, the tympanum is generally conspicuously unpigmented (Fig. 2) (dark and indistinct in other species), and the snout is truncate and broad, the nostrils opening laterally (Fig. 2) (anterolateral opening in other species). Fig. 5 shows a comparison between the shapes of the snouts of *C. tyleri* sp. nov., *C. minor* and *C. pipiens*. *C. oxyrhina* is so variable as to preclude its representation by a single morphotypy (Burton & Stocks, 1986).

Copiula tyleri sp. nov. differs from *C. fistulans*, *C. minor* and *C. oxyrhina* in having a direct ligamentous attachment between the ilium and sacrum. *C. pipiens* shares the *C. tyleri* condition, but can be distinguished by characters of the dorsum, tympanum and snout noted above, and probably by colour in life, as *C. pipiens* is tinged orange-pink in areas of the back and vent, compared with Zweifel's account of *C. tyleri* above. The snout of *C. pipiens* is relatively long (min. SN/E 1.45 compared with *C. tyleri* max. SN/E 1.31) (Fig. 5).

The shared possession of a direct ligamentous attachment between the ilium and sacrum may suggest that the closest relation of *C. tyleri* sp. nov. is *C. pipiens*, but the polarity and hence utility of this character is unknown (Burton 1986). The range of *C. pipiens* is poorly known: the only specimens were obtained from the Wewak area (Fig. 4). The range of *C. tyleri* apparently surrounds that of *C. pipiens*, but there is no information to suggest that the ranges of the two species abut or overlap.

Unidentified mainland specimens

Two specimens from Mt Nomò, Irian Jaya (BM NH 1938.6.6.2-3) probably represent a further undescribed species. Both are small (S-V 19.1, 18.3), slender and little pigmented, and BMNH 1938.6.6.2 possesses a very long snout. Unfortunately, these specimens are in poor condition because of previous exploratory dissection and it is impossible to sex or age them, or to determine the relationship between the ilium and sacrum.

AMNH 49536 and 49554 (juvenile) from Bernhard Camp, Idenburg River, Irian Jaya cannot be referred to the species closest geographically, *C. pipiens* and *C. tyleri*, as they lack the direct ligamentous attachment between ilium and sacrum. They resemble most closely the geographically distant *C. oxyrhina*. Similarly, AMNH 79961 (S-V 27.4 mm) from Soliabeda, Chimbu Province (Fig. 4) falls into the size range of *C. fistulans*, but the site is 250 km to the west of the known range of that species. Each instance may represent either a range extension or a new species, but either more specimens to allow a study of variation or call data are needed before their identity can be resolved.

RMNH 5256 and 5269 from Timena River, Irian Jaya are tiny (S-V 15.3 mm, 15.7 mm), and appear juvenile. It is therefore impossible to determine their specific identity.

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specimens, and to him my debt is incalculable. Zweifel also provided the map on which Fig. 4 is based. M. J. Tyler and M. Davies read the manuscript and provided valuable criticisms. Much of the work was undertaken whilst I was a Visiting Research Fellow in the Department of Zoology, University of Adelaide.

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**ON THE TAXONOMIC STATUS OF THE AUSTRALIAN CHITON
PARACHITON VERCONIS (COTTON & WEEDING, 1939)
(MOLLUSCA: POLYPLACOPHORA: LEPTOCHITONIDAE)**

BY K. L. GOWLETT-HOLMES

Summary